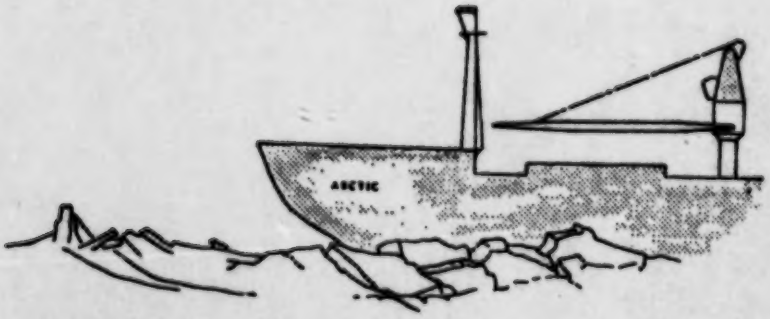
MM

TP 3657

M.V. ARCTIC

LAKE MELVILLE 1981 PROBE

DATA COLLECTION SERVICES



PREPARED FOR

TRANSPORTATION DEVELOPMENT CENTRE

BY

FENCO CONSULTANTS LTD.

AND

GERMAN + MILNE INC.

OCTOBER 1981

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DTC 801
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MM

Planning
Engineering
Project Management

FENCO

1311-9th Ave. S.W.
3rd Floor
Calgary, Alberta T3C 0H9
403-237-6466
Cable 'FENCOENG'
Telex 03-821373

May 21, 1982

Mr. M. Brenckmann
Transportation & Development Centre
1000 Sherbrooke Street West
Pl. de l'Aviation
MONTREAL, Quebec
H3A 2R3

Transport Canada / Transports Canada
Library and Information Centre /
Centre de Documentation GSLA
Ottawa, Canada K1A 0N5

Dear Mr. Brenckmann,

M.V. ARCTIC - LAKE MELVILLE 1981 PROBE

Please find enclosed twenty-five (25) copies of the final report on M.V. Arctic Lake Melville 1981 Probe.

We hope that this final version of the report meets with your approval.

Yours very truly
FENCO CONSULTANTS LTD.

K. K. Vij
SENIOR SCIENTIST

KKV/mh
10026-50
Encls.

M.V. ARCTIC

LAKE MELVILLE 1981 PROBE

DATA COLLECTION SERVICES

BY

FENCO CONSULTANTS LTD.

AND

GERMAN + MILNE INC.

PREPARED BY

B. BARRY NAROD

OCTOBER 1981

The contents of this report reflect the views of the Contractor and not necessarily the official views or policies of the Transportation Development Centre.

PERSONNEL

Dr. B. Narod, FENCO CONSULTANTS LTD.,
Calgary, Alberta

Mr. J. Stirling, German + Milne Inc.,
Montreal, Quebec

ACKNOWLEDGEMENTS

We are grateful to the captains and crew of the M.V. Arctic for their willing assistance with our work on board.

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17. Abstract

The report provides a log of the maintenance and data collection activities carried out by the author utilising the permanently installed instrumentation system aboard the vessel preceding and during a probe of Lake Melville, Labrador, made by M.V. "Arctic" in February and March 1981.

Whilst approaching the entrance to the lake, the vessel traversed the Labrador pack ice, and during the period of the probe into the lake the vessel encountered level ice that varied in thickness from 0.58 to 1.3 metres, as well as severe ridging. Video recordings were also taken with the aid of the integrated closed circuit T.V. system. In all a total of 17 data tapes and 7 video tapes were generated during the transit of the ice pack and Lake, which was successfully accomplished by the vessel.

A partial analysis of the data obtained during this probe is contained in a report produced by Melville Shipping Ltd, and entitled "M.V. "Arctic" Experimental Voyage to Lake Melville, Labrador, in February/March 1981 - TP 3646E.

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17. Résumé

L'auteur de ce rapport rend compte de ses travaux sur la saisie de données à l'aide des appareils installés à demeure à bord du brise-glace Arctic, et sur la maintenance de ces appareils, avant et pendant les essais que ce navire a effectué en février et mars 1981 dans le lac Melville, au Labrador.

Avant d'entrer dans ce lac, le navira a dû franchir le pack du Labrador et, tout au long des essais dans le lac, il a navigué dans des bancs de glaces d'une épaisseur allant de 0.58 à 1,30 m, et a traversé d'importantes crêtes de glace. Des enregistrements video ont également été pris à l'aide du système intégré de télévision en circuit fermé. En tout, 17 rubans magnétiques et 7 rubans video ont été enregistrés pendant le franchissement du pack glacé et durant les essais dans le lac, alors que le navire accomplissait son périple sans encombre.

Une analyse partielle des données recueillies durant les essais, exécutée par la Melville Shipping Ltd intitulée "M.V. Arctic Experimental Voyage to Lake Melville, Labrador, in February/March 1981" - TP 3646E est incorporée au rapport.

18. Mots-clés	19. Diffusion
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M.V. ARCTIC LAKE MELVILLE 1981 PROBLE

DATA COLLECTION SERVICES

1. INTRODUCTION

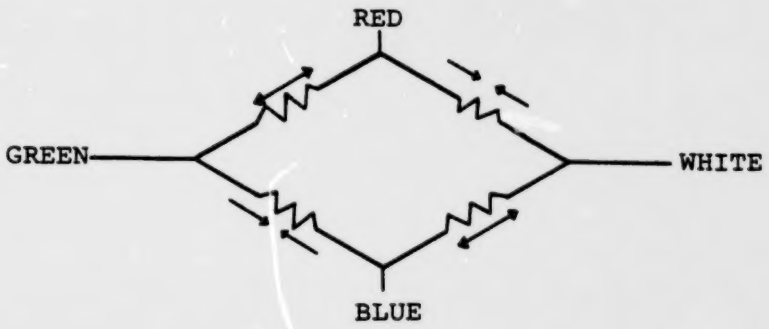
The M.V. Arctic, a CASPPR Class II bulk carrier, made a probe into Lake Melville in February and March 1981, in order to demonstrate and gather data concerning winter-time Marine Transportation capability and potential in the region. FENCO CONSULTANTS LTD., in conjunction with German + Milne Inc., were contracted to operate and maintain the instrumentation system aboard the M.V. Arctic during the test period. This report details the maintenance work carried out and gives complete information on the data tapes recorded.

Full details of the tests performed and analysis of the ship's performance during the probe are contained in the report by Melville Shipping Ltd.

2. TECHNICAL LOG

February 17, 1981

The torque meter was examined. The strain gauge circuit is as follows:



Extensive strain gauges are marked (⟷), compressive gauges are marked (→ ←). Resistance value of all the gauges is 120Ω.

February 18, 1981

A new shaft speed indicator was built and installed in Channel 211. The system also uses spaces 210 and 209. For schematic and calibration, see additions to the hardware manual, M.V. Arctic System Operation and User's Manual, Volume II, Section 3.7.

February 22, 1981

The following strain gauges were found inoperative:
Channels 41, 102, 103, 112, 116.

February 23, 1981

Strain gauge calibration was performed and recorded on magnetic tape. Each viable gauge was shunted by a 28 k resistance for this purpose. The details below give the tape number, the start and stop time of each file on the tape, the channel numbers recorded in each file, the sampling rate and the sampling mode of the channels recorded.

For example: 01 Start 13:14:00 Stop 13:17:02 32-47 3, R,

would mean that start and stop time of file 01 is 13:14:00 and 13:17:02 respectively; the channels recorded in this file are viable gauge numbers 32 through 47 inclusive; the sampling rate is 3 (10 samples per second) and the recording is in the real mode (R). The other recording mode is the peak-hold and is designated as P. (For details of

sampling rate code and the sampling mode, refer to M.V. Arctic System Operation and User's Manual, Section 3, Volume I).

Tape C1

File 01	Start 13:14:00	Stop 13:17:02	32-47	3, R
02	Start 13:18:10	Stop 13:20:47	48-63	3, R
03	Start 13:21:53	Stop 13:25:06	64-79	3, R
04	Start 13:26:33	Stop 13:28:44	80-95	3, R
05	Start 13:30:10	Stop 13:32:25	96-111	3, R
06	Start 13:33:30	Stop 13:35:34	113-127	3, R
07	Start 13:37:58	Stop 13:40:09	128-143	3, R
08	Start 13:40:52	Stop 13:43:17	144-159	3, R
09	Start 13:44:18	Stop 13:46:45	160-175	3, R
10	Start 13:48:38	Stop 13:50:33	16-31	3, R
EOT written				

February 24, 1981

On playback, Tape C1 was found alright though the header problem still remained.

Tapes C2, C3 and C4

The details of the type of sensor and the sampling pattern of each sensor recorded on these tapes is given below:

Sensor	Sampling pattern
All viable strain gauges	2, P
All accelerometers	3, P
All performance sensors	2, R
Channels 52, 53, 65, 107, 109, 124, 164, 165, 173, 209	5, R

Tape C2

File 00 Start 07:15:00
System crashed shortly after use. Tape scrapped.

Tape C3
File 00 Start 07:46:10
Stop 08:49:14
EOT Written

Tape C2 (Rerecorded)
File 01 Start 08:56:14
Recording stopped due to system crash.

Tape C4
File 00 Start 10:05:53
Stop 11:13:24
EOT written

The following additional strain gauges were found inoperative: Channels 56, 76, 136, 149.

All the strain gauges were zeroed again and following the earlier procedure, calibration was performed again and recorded on the tapes.

Tape C5

File 00	Start 17:58:52	Stop 18:08:09	Sampling as for C2-4		
01	Start 18:08:50	Stop 18:08:59	Dummy		
02	Start 18:49:50	Stop 18:51:53	16-31	3, R	
03	Start 18:52:50	Stop 18:55:01	32-47	3, R	
04	Start 18:55:30	Stop 18:57:56	48-63	3, R	
05	Start 18:58:30	Stop 19:00:53	64-75	3, R	
Crash					

Tape C6

File 00	Start 19:08:59	Stop 19:09:14	Dummy		
01	Start 19:10:30	Stop 19:12:51	80-95	3, R	
02	Start 19:13:30	Stop 19:16:16	96-111	3, R	
03	Start 19:16:41	Stop 19:18:59	112-127	3, R	
04	Crash		128-143	3, R	
EOT Written					

Tape C7

File 00	Start 19:25:50	Stop 19:26:00	Dummy		
01	Start 19:26:50	Stop 19:28:46	128-143	3, R	Invalid
02	Start 19:28:53	Stop 19:30:56	128-143	3, R	
03	Start 19:31:38	Stop 19:33:48	144-159	3, R	
04	Start 19:34:30	Stop 19:37:08	160-175	3, R	
EOT written					

February 26, 1981

The T.V. camera controls were repaired. Relay #3 on the decorder board was fixed and a broken wire on the driver board was replaced. No spares were needed.

February 27, 1981

Recordings for the Lake Melville probe started. The sampling pattern for the recordings were the same as for Tapes C2 to C4 with the exception that whenever the channels recorded with the pattern (5, R) are included, it is referred to as "Fast" pattern and when they are excluded from the recordings it is referred to as the "Slow" pattern.

Tape C8

File 00	Start 09:16:30	Stop 09:16:53	Dummy
01	Start 09:16:57	Stop 12:23:02	Sampling pattern "Slow"
EOT written			

Tape C9

File 00 Start 12:23:30 Stop 12:23:51 Dummy
01 Start 12:23:55 Stop 15:32:05 Sampling pattern "Slow"
EOT written

Video time synchronized at 09:00
Video time synchronized at 10:30 (8 seconds slow)
Video time synchronized at 14:24 (18 seconds slow)

Tape C10

File 00 Start 15:43:58 Stop 15:44:21 Dummy
01 Start 15:44:30 Stop 17:06:15 Sampling pattern "Slow"
EOT written

Video time at 16:51 found 11 seconds slow

February 28, 1981

Channels 32, 52 deleted from recordings.

Channels 53, 64, 65, 107, 109, 125, 164, 165, 173 added at sampling pattern -, 5, R (Fast).

Tape C10 (Continued)

File 02 Start 11:05:00 Stop 11:05:09 Dummy
03 Start 13:42:59 Stop 14:05:02 Sampling pattern "Fast"
EOT written

Video time at 13:42 found 11 seconds slow.
Video time synchronized at 14:05:00.

March 1, 1981

Tape C11

File 00 Start 08:49:50 Stop 08:50:21 Dummy
01 Start 08:50:30 Stop 11:58:24 Sampling pattern "Slow"
EOT written

Video time at 08:50 found 1 second slow

For tape C11, Pitch and Roll gyros were added to the sampling pattern. The sampling rate was 2 (1 sample per second) in the real mode R.

Calibration:

Roll Gyro:

Gyro sensitivity $\pm 5°$ gives $\pm .5$ V.
Gain = 10, ± 5 V on amplifier output.

The conversion routine now is:
120N - 60 where Roll = -5° when N = 0
and Roll = +5° when N = 1
Therefore ±5°roll corresponds to 60 software degrees.

The conversion routine constants on page A-71 of the software manual should M.V. Arctic System Operating and User's Manual Volume II should now read:

Roll 240
-
-
LINU
3
100
-50

Pitch Gyro:

The set-up for Pitch gyro is same as for the "Roll" gyro. The conversion routine constants on page A-71 should now read:

Pitch 239
-
-
LINU
3
100
-50

At present "Roll" reads 4 X 12, too big, "Pitch" reads X 9, too big.

Tape C12

File 00 Start 11:59:10 Stop 11:59:37 Dummy
01 Start 11:59:41 Stop 15:13:22 Sampling pattern "Slow"
EOT written

Bins 2, 3 rezeroed at 11:59.
Gauges 42, 50, 78, 79, 104, 113, 117, 134, 138, 148 rezeroed at 13:15.
Bin 1 down.
Gauges 160, 59 rezeroed at 13:37.
Video time at 14:19:00 found 12 seconds slow.

Tape C13

File 00 Start 15:14:17 Stop 15:14:48 Dummy
01 Start 15:14:53 Stop 18:19:59 Sampling pattern "Slow"
EOT written
Video time at 18:20 found 15 seconds slow.

March 2, 1981

Video time found 51 seconds slow. Synchronized at 08:41.

Ground line of Bin 1 found broken and was repaired.
Channel 21 still off; amplifier operational.
Video time found 20 seconds slow at 13:14:00.

Tape C14

File	00	Start 13:13:10	Stop 13:13:52	Dummy
	01	Start 14:15:50	Stop 14:19:27	Sampling pattern "Fast"
	02	Start 14:23:30	Stop 14:26:09	Sampling pattern "Fast"
	03	Start 14:31:50	Stop 14:37:56	Sampling pattern "Fast"
	04	Start 14:45:13	Stop 14:49:16	Sampling pattern "Fast"
	05	Start 14:51:10	Stop 14:55:11	Sampling pattern "Fast"
	06	Start 15:48:30	Stop 15:54:53	Sampling pattern "Fast"
	07	Start 20:49:30	Stop 20:56:32	Torque calibrate
	08	Start 21:36:35	Stop 21:36:45	Channel 21 check

Recording of data on File 01 to 06 is while breaking the ice in "ramming" mode.

Torque Calibration:

Red-White Shunt	Printer	mV
59.83 k	413 kNm	1572
119.88 k	234	899
00	55	222

Video time synchronized at 15:48 found 43 seconds slow.

March 3, 1981

Video time synchronized at 08:02 found 57 seconds slow.

Tape C14 (Continued)

File	09	Start 08:11:35	Stop 08:35:00	Sampling pattern "Slow"
	10	Start 08:55:58	Stop 10:13:49	Sampling pattern "Slow"
	EOT written			

Tape C15

File	00	Start 10:14:32	Stop 10:34:05	Dummy slow
	01	Start 10:34:10	Stop 11:09:17	Sampling pattern "Slow"
	02	Start 11:11:30	Stop 11:11:40	Dummy
	03	Start 11:15:50	Stop 11:16:56	Sampling pattern "Fast"
	04	Start 11:19:34	Stop 11:28:42	Sampling pattern "Fast"
	05	Start 11:30:10	Stop 11:30:56	Sampling pattern "Fast"
	06	Start 11:45:10	Stop by Crash	Sampling pattern "Slow:

Note: Data in File 04 corresponds to breaking ice mode while ramming a ridge.
Video time at 11:39 found 13 seconds fast.

Tape C16

File 00	Start 01:11:11	Stop 01:11:36	Dummy		
01	Start 01:11:40	Stop 04:11:45	Sampling pattern "Slow"		
EOT written					

March 4, 1981

Strain gauge calibration was performed and recorded using a 28 k shunt resistance.

Tape C17

File 00	Start 21:48:10	Stop 21:48:44	Dummy	
01	Start 10:01:16	Stop 10:02:46	16-31	3, R
02	Start 10:03:31	Stop 10:09:09	32-79	3, R
03	Start 10:10:34	Stop 10:14:19	80-127	3, R
04	Start 10:14:54	Stop 10:18:33	128-175	3, R
05	Start 10:19:30	Stop 10:22:06	Dummy	
EOT Written				

File 00 was recorded on March 3, 1981.

Note: On rudder command and response, both labels were tested and were found incorrect. These labels should be (+ Starboard, - Port).

3. LIST OF VIDEO TAPES

V1: Friday, February 27
V2: Saturday, February 28
V3: Sunday, March 1
V4: Monday, March 2
V5: Tuesday, March 3
V6: Tuesday, March 3, 2:30 - 3:35 p.m.
V7: Tuesday, March 3, 3:35 - 4:00 p.m.

4. LIST OF COMPUTER TAPES

The tapes recorded on the ship have been reformatted using the University of British Columbia computer facility. This was done to ensure that each data file finished with an end-of-file mark, a feature not guaranteed with the on board data acquisition system. All the recorded data were rewritten in higher tape density (1600 BPI) onto 13 new tapes as listed below.

Tape C1, C5, C6, C7, C17	Composite Copy 1600 BPI
New Tape	Old Tape
File 01	C1 File 01
02	02
03	03
04	04
05	05
06	06
07	07
08	08
09	09
10	10
11	C5 00
12	02
13	03
14	04
15	05
16	C6 01
17	02
18	03
19	C7 01
20	02
21	03
22	04
23	C17 01
24	02
25	03
26	04
27	05
EOT written	
New Tape	C2 Copy 1600 BPI
File 01	C2 File 01
EOT written	
New Tape	C3 Copy 1600 BPI
File 01	C3 File 00
EOT written	
New Tape	C4 Copy 1600 BPI
File 01	C4 File 01
EOT written	

```
New Tape                                C8 Copy 1600 BPI
File 01                                 C8 File 01
EOT written

New Tape                                C9 Copy 1600 BPI
File 01                                 C9 File 01
EOT Written

New Tape                                C10 Copy 1600 BPI
File 01                                 C10 File 01
     02                                          02
     03                                          03
EOT written

New Tape                                C11 Copy 1600 BPI
File 01                                 C11 File 01
EOT written

New Tape                                C12 Copy 1600 BPI
File 01                                 C12 File 01
EOT written

New Tape                                C13 Copy 1600 BPI
File 01                                 C13 File 01
EOT written

New Tape                                C13 Copy 1600 BPI
File 01                                 C13 File 01
EOT Written

New Tape                                C14 Copy 1600 BPI
File 01                                 C14 File 01
     02                                          02
     03                                          03
     04                                          04
     05                                          05
     05                                          06
     07                                          07
     08                                          08
     09                                          09
     10                                          10 Read error at
                                                 Block 6317
EOT written at File 10 Block 6316

New Tape                                C15 Copy 1600 BPI
File 01                                 C15 File 01
     02                                          02
     03                                          03
     04                                          04
     05                                          05
     06                                          06 to Block 7701
EOT written
```

```
New Tape
File 01
EOT written
```

```
C16 Copy 1600 BPI
C16 File 01
```

5. TAPE USER INFORMATION

5.1 Description of Tape Format

a) Tape Format

Data tapes are written at 1600 bpi in NZRI format with odd parity (IBM compatible). Nine-track tapes are used. A data tape contains one or more data files. A data file consists of a header block, a variable number of data blocks, and an end-of-file mark. Two consecutive end-of-file marks denote the end-of-tape (no more data files recorded on the tape).

b) Header Block Format

The header block is of fixed length, containing 1546b words of 16 bits each. A header block occurs at the beginning of every file.

Word	Contents
1	Year
2	Month
3	Day — Date and time (6 words)
4	Hour
5	Minute
6	Second
7	Logging Interval (in minutes)
8	Recording Mode (-1 for recording, 0 for standby)
9	Number of Sensors (255)
10	Spare
11-522	Rate and Mode Table (512 words)
	Bits — Contents (value)
	(msb)0-2 — Unused (0)
	3-5 — Rate(0-7)
	6 — Mode (0=P; 1=R)
	7-15 (lsb) — Address (1-255)
523-1034	Alarm Limit Table - Minimums (512 words)
1035-1546	Alarm Limit Table - Maximums (512 words)

c) Data Block Format

When the system is recording, two data blocks are recorded each second. A data block is of variable length, from a minimum of 10 words to a maximum of 4096 words. The first eight words specify the date and time of the record, the recording mode and whether this is the first or second record of the pair for the second. The following words are the data records, grouped in pairs. The first word in each pair specifies the address of the sensor sampled (1 to 255). The second word is the reading obtained from that sensor (0 to 1023).

Word	Contents
1-6	Date and Time (Same as Header)
7	Block Type - Continuous Recording n Standby Triggered into Recording (n more blocks will be recorded) n is Decremented in Successive Records 1 Standby Logging (once per hour two successive records with one in this field are written)
8	Index Number (first or second for this second)
9	Sensor Address (1-255)
10	Reading (0-1023) (0 = -10 V) (1023 = +10 V)
11-12	Second Data Record (similar to words 9 and 10)

5.2 Conversion Equations

a) Hull Structure Sensors

Strain Gauges (F = 1.77) $S = 2410 \frac{IVAL}{512} - 2410$

Channels 34, 43, 155

Strain Gauges (F = 1.83) $S = 2331 \frac{IVAL}{512} - 2331$

Channels 45, 50, 57, 59, 66-67, 69-70, 75, 81, 84, 89, 91, 95, 105, 110, 120, 121, 127, 131, 132, 158, 160, 163

Strain Gauges (F = 1.90) $S = 2245 \frac{IVAL}{512} - 2245$

Channels 19, 21, 38, 71

Strain Gauges (F = 1.95) $S = 2177 \frac{IVAL}{512} - 2177$

Channels 20, 28, 33, 36, 39-42, 46, 51, 53-56, 63, 72-74, 85, 88, 90, 93, 94, 97-104, 106, 111-118, 122, 126, 129, 130, 133-139, 141, 142, 144-149, 151-154, 156, 157, 159, 161, 162, 166, 167, 169, 170

Thermistors

Not used in 1980

Draft in metres

$$D = 3.05 \frac{IVAL}{1024} + 7.93$$

Channel 252 = fwd
Channel 253 = aft

b) Ship Performance Sensors

Ship Speed in Knots

$$S = 30. \frac{IVAL}{1024}$$

Channel 236

Ship's Head in Degrees

$$Temp2 = 20. \frac{IVAL(237)}{1024} - 10$$

Channel 237 = Sine
Channel 238 = Cosine

$$Temp1 = 20. \frac{IVAL(238)}{1024} - 10$$

$$H = 57.2958 \text{ Arctan } \frac{Temp1}{Temp2}$$

Pitch and Roll in Degrees

$$\text{Angle } 5 \frac{IVAL}{512} - 5$$

Channel 239 = Pitch: pos = bow down
Channel 240 = Roll: pos = to stbd

Accelerometers in g

$$A = 2.5 \frac{IVAL}{512} - 2.5$$

Channel 1 Fwd Heave: pos = up
Channel 31 Fwd Surge: pos = forward
Channel 2 Fwd Sway: pos = port
Channel 214 Aft Heave: pos = up
Channel 212 Aft Surve: pos = forward
Channel 213 Aft Sway: pos = port

c) Propulsion and Steering Sensors

Propellor Pitch Setting

$$C = 10. \frac{IVAL}{512} - 10$$

Channel 244 = command (in units)
Channel 201 = response (in degrees)
Positive = Forward

$$R = 19. \frac{IVAL}{512} - 15$$

Rudder Angle in Degrees

$$A = 40. \frac{IVAL}{512} - 40$$

Channel 245 = command
Channel 200 = response
Positive = Starboard

Propellor Differential Pressure

Not working.

Rudder Differential Pressure in MPa Channel 202	$P = 34.5 \frac{IVAL}{1024}$
Fuel Rack Setting in % Channel 199	$F = 0.2201.\ IVAL - 9.97$
Thrust in Tonnes Channel 198	$T = 120. \frac{IVAL}{512} - 120$
Torque in ft. lbs. Channel 208	$T = 1328\ (IVAL - 102.4)$
Shaft RPM min^{-1} Channel 211	$RPM = \frac{1203.6}{0.01963.\ IVAL + 0.09}$

d) Bubbler System

Bubbler Pressure (in kPa) Channel 187 Channel 188	$P = 34.6 \frac{IVAL}{1024}$

e) Environmental Sensors

Cloud and Ice Cover in Tenths Channel 224	$C = 10. \frac{IVAL}{1024}$
Visibility in Nautical Miles Channel 224	$V = 10. \frac{IVAL}{1024}$
Air Temperature in Degress C Channel 231	$T = 100. \frac{IVAL}{512} - 100$
Relative Humidity in % Channel 232	$H = 100. \frac{IVAL}{1024}$
Barometric Pressure in kPa Not Used	
Wind Speed in Knots Channel 233	$S = 6.95\ (20. \frac{IVAL}{1024} - 10)$
Wind Direction in Degrees Relative to Ship's Head Channel 234	$D = 360 - 360. \frac{IVAL}{1024}$